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Observations on the Food Habits of Postlarval Chiggers (Acarina, Trombiculidae) [1]

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Abstract

Although some nymphal and adult chiggers feed on quiescent stages of other small arthropods, those of our commonest chiggers utilize eggs of arthropods as their principal food. By offering postlarval chiggers laid eggs or dissected ovarian material of 21 arthropod orders (a total of 152 species), considerable insight into normal foods was acquired. The Collembola, Diptera, Hemiptera, Homoptera, and Lepidoptera are the large orders which lay eggs attractive to chiggers. The Coleoptera and Orthoptera have relatively unattractive eggs. Certain eggs are toxic, at least when infected with Penicillium.

Introduction

The purpose of this paper is to present information collected over a period of several years on the feeding behavior of nymphal and adult chigger mites. During this time eggs, dissected ovaries, and whole bodies of more than 150 species of insects and other arthropods were offered to postlarval stages of chiggers and the success of the chiggers in making use of these foods was recorded.

Of all the groups of medically important arthropods, chiggers have been among the most difficult to rear, principally because of problems in feeding the postlarval stages. Curiously, this is the group in which rearing is most essential in disease transmission studies, for a chigger bites a vertebrate host but once unless disturbed. Transovarian transmission is therefore an essential part of the disease-vector relationship, and rearing is necessary if laboratory transmission studies are to be completed.

Historical Account

Migajima and Okumura, 1917, succeeded in rearing Trombicula akamushi (Brumpt) in jars containing soil and supplied with fresh vegetable matter. Hatori, 1919, did not succeed in duplicating this rearing experiment. Ewing, 1925, offered springtail feces and dead springtails to a female Trombicula alfreddugesi (Oudemans) from which larvae were later obtained. Nagayo et al., 1921, offered decomposing vegetable matter to several species of Trombicula.

Michener, 1946, succeeded in rearing Trombicula (Eutrombicula) batatas (Linnaeus) in Panama although the food of the nymphs and adults was not known. The culture methods of Michener, 1946, and of Melvin, 1946, were similar; culture jars containing a mixture of soil and chicken manure were used. Michener's jars were "medium sized fruit jars with the bottom removed and replaced by a plug of plaster of Paris;" the jars were also lined with plaster of Paris. Michener concluded, "that living animals, portions of green plants (e. g. rootlets), as well as excreta and freshly dead animals and plants are not necessary for the growth of nymphs and adults" of T. batatas. Also, "...that the nymphs and adults feed on soil moisture rich in organic matter."

The best explanation of these observations appears to be that the chiggers were cannibalistic (these authors never succeeded in rearing isolated individuals). Cannibalism among chiggers is known; the quiescent forms are those most generally eaten. The insect or mite eggs in the soil or

manure may have provided some food even though killed by heat, although this is improbable if the protein matter of these eggs coagulated during the exposure to heat.

The first feeding observations were those of Wharton and Carver, 1946, and Wharton, 1946, when the eggs of Aedes aegypti (Linnaeus), Culex quinquefasciatus Say, C. jepsoni Theobald, and Drosophila sp. were eaten; in addition, the dissected eggs of Tribolium sp., fly eggs, and the eggs and first instar larvae of ants were eaten by the post-larval stages of Euschöngastia indica (Hirst).

In 1947, Jenkins reared four generations of T. alfreddugesi and T. splendens (Ewing) with an approximate efficiency of 70 per cent per generation. The food for the post-larval stages were the eggs of Aedes aegypti, but the large quantity of mosquito eggs required was noted as a disadvantage.

Jayewickreme and Niles, 1947, used the eggs, ovaries, and adults of Mansonia uniformis (Theobald) as well as freshly killed Collembola and psocids; but for routine feeding it was more convenient to use culicine eggs, and the eggs of Culex fatigans Wied. were used primarily.

Jenkins, 1948, suggests that mosquito eggs (Aedes and Psorophora) laid in dry depressions in the summer may serve as food for the adults of T. splendens.

Jones, 1951, reports the failure of nymphs of Trombicula autumnalis (Shaw) to feed on "the eggs of various insects" (including Aedes eggs) offered to them. He successfully reared this species on a Drosophila culture medium consisting of yeast, agar, and molasses. The mixture was not readily taken; however, Jones induced the nymphs to ingest the mixture by forcing them into it. He adds, "The feeding behavior of many nymphs was inexplicable."

Feeding Behavior

The food of nymphal and adult trombiculids consists of a variety of insects and arachnids, their eggs, bodies, or fresh remains. It is probable that insects provide the major portion of

this nourishment. It is reasonably certain that early (1917-1946) suggestions concerning other food sources were incorrect and that success of these authors in rearing occasional chiggers resulted from cannibalism or contamination of cultures with other arthropods. Food possibilities other than insects and arachnids may include such terrestrial forms as isopods and snails. The latter were a possible food source in laboratory mass cultures of Trombicula splendens.

Although little is known as to what foods are available and acceptable to postlarval chiggers in nature, there are indications from laboratory findings as to the probable feeding habits of a number of species of trombiculids in the subfamilies Trombiculinae, Walchiinae, and Leeuwenhoekiinae. In general, the feeding preferences of these support the morphological evidence relative to their probable phylogeny.

Neoschöngastia, Pseudoschöngastia, and Walchia in the laboratory would not feed on any eggs or any ovarian material offered them. They ate instead freshly dead or maimed Collembola (Sinella) or Collembola immobilized by molting. In nature they also probably feed on resting stages of various small insects.

The nymphs and adults of Trombicula may utilize similar food, but as shown by the feeding trials reported below, most species apparently feed principally on insect eggs, and in the laboratory will feed on oocytes dissected from female insects. Similar habits are characteristic of Hannemania and Euschöngastia.

Simulated Feeding

Nymphs and adults often appear to feed on a variety of substances, both organic and inorganic, within their environment, but they apparently do not obtain nourishment except from the sources described above. Wharton and Carver, 1946, state: "...even though the gnathosoma was pressed against the substratum and the opisthosoma was expanded and contracted, it is doubtful whether the nymphs were successful in taking food." When hungry, the nymphs and adults engage in simulated

acts of feeding on the substratum as well as on bits of wood, fragments of loose plaster, or bits of other debris. These simulated acts of feeding may indicate that traces of food remain and are detectable.

Futile attempts to feed seem to be rare in new culture dishes; but when suitable food was placed in a new dish and then all visible traces removed immediately, the areas contacted by the food became attractive to unfed adults. When the content of an insect egg was smeared on the substrate, that which was not absorbed was eaten; such spots remained attractive even after the dried egg content could no longer be taken successfully as food, and the removal of all visible traces did not remove the apparent interest in the area contacted by the food until many hours later. An empty egg shell is often subjected to repeated cheliceral punctures and may be of apparent interest as food for from one to several days.

Feeding Trials

Chigger cultures were established in the spring of 1948, when a variety of insects and their eggs (either as dissected ovaries or as laid eggs) were offered as food to the nymphs and adults. The ovaries of Drosophila were readily eaten but the quantity of food obtained from each female was too small and the laid eggs were not very satisfactory. Dermestes lardarius ovaries appeared to be repellent in most cases although a few punctures were made in the immature oocytes. Dermaptera eggs were readily accepted but were not obtainable in great quantities. In view of these experiences an extensive series of trials, reported in table I, were undertaken to determine what foods would be most useful for laboratory purposes as well as what foods are probably important in nature.

The large testes of a number of insects were offered to adult chiggers but no interest was ever shown in these organs.

Coincident with these feeding trials, several species of Collembola were cultured, and among these Sinella curviseta Brook proved to be ideally suited for providing food to chigger cultures (see Lipovsky, 1951). This springtail can be kept

in cultures with chiggers and fed yeast pellets; eggs laid by the springtails provide chigger food, as do the immobile forms of these insects. Collembola eggs tried other than those of the Entomobryidae provided little or no food for chiggers.

Table I shows the results of feeding trials using cultures of Trombicula, principally the pest chiggers T. (Eutrombicula) alfreddugesi and T. (E.) splendens, although T. gurneyi Ewing, T. montanensis Brennan, and possibly others were present in some of the early cultures.

The insect eggs or ovaries offered to the chiggers listed above represent 18 orders, and in addition to these, spider eggs, tick eggs, dissected phalangid eggs, and some mites and their eggs were offered. Dissections were often made from fresh specimens but more commonly insects preserved in detergent and water and refrigerated for as much as two weeks were used. No differences were observed in the acceptability of dissected ovarian material depending on whether the specimens were fresh or preserved in this way, unless the tissue had been frozen. Ovarian materials that had been frozen seemed less acceptable to chiggers.

In table I, numbers in parentheses represent number of trials. Under laid eggs the numbers correspond to number of eggs, under dissected eggs and oocytes the numbers represent dissected entire ovaries; the number 50 generally represents groups exceeding, in some cases by several hundred, this number; below 50 the estimates are more precise.

Symbols used in the table are as follows:

-	Repellant to the chiggers.
O	No influence on the chiggers.
A	Attractive but eggs apparently too hard to puncture.
D	Delayed punctures in hard eggs.
C	Possibly eaten by Collembola cultured with chiggers.
X	Few eggs punctured.
XX	Frequent punctures.
XXX	All eggs punctured.
G	Good.
F	Fair.
P	Poor.

Conflicting symbols in a single row in a single column indicate that different trials gave different results.

Letters in the last column are judgements based not only on the feeding trials but on places where eggs are deposited by the insects concerned. The nymphal and adult chiggers involved live in the soil or about rotting wood.

The observations on feeding were principally visual, punctures being recorded if a chigger was observed feeding. Rarely, collapsed eggs were used as evidence of feeding and recorded as punctures.

Notes on Foods

These comments are based on the same species of chiggers which were used to provide the data for table I.

1. Collembola:-- As previously indicated (Lipovsky, 1951) only the entomobryids, with particular reference to Sinella curviseta Brook, are suited for culturing with chiggers. Eggs provide most of the food but molting or freshly dead postembryonic stages of Sinella are also eaten. Sinella requires no food in addition to active dried yeast. although some additional food may be available in the form of organic matter which is occasionally present in cultures. Sinella curviseta is easy to culture; however it apparently does better under fluctuating temperatures and a relative humidity of 80 to 100 per cent. It cannot withstand freezing, and occasionally old cultures lose their reproductivity for several weeks, presumably due to the accumulation of feces or to an overabundance of acarid mites.

2. Orthoptera:-- The Orthoptera probably provide but little chigger food in nature, although eggs of some small crickets and grasshoppers may be eaten. The small oocytes of Locustidae, Gryllidae, and Tettigoniidae, and the mature eggs of Gryllus appeared most favorable as food for chiggers in the laboratory. The mature and half grown oocytes of some appeared to be repellant. The eggs of Periplaneta americana, removed from the ootheca, were obviously repellant.

3. Neuroptera:-- The ovaries of Sialidae, Hemerobiidae, and Chrysopidae were about equal in value as food. Of eight hemerobiid eggs, seven were eaten within four and one half hours. The large leathery ascalophid eggs were of no influence even after the content of one egg was exposed; also, these eggs deteriorated rapidly. The eggs of some Neuroptera may be available in nature, although they are probably of little importance.

4. Ephemerida:-- Although Mayfly eggs may be available for culturing often in large numbers (squeezed from the females), they are very small and apparently are punctured by adults only after repeated attempts (see Plecoptera). Because they are extremely small, the nourishment obtained after successful penetration of the egg shell was probably slight. It was not determined whether nymphs were capable of puncturing the eggs.

5. Odonata:-- The mature eggs and immature oocytes dissected from one female of Libellula pulchella were estimated to be sufficient to feed 500 or more adults of T. splendens. The eggs and oocytes were soft and readily eaten. From five to ten adults could feed from an egg simultaneously.

6. Plecoptera:-- Both ovaries and laid eggs were used in these tests. The eggs were light to dark brown in color; the lightly pigmented eggs were punctured and eaten with but slight delay. The dark brown eggs usually remain in cultures for several days before they were eaten; the laid eggs were usually the darkest, and these eggs were found attached to many females. The probable reason for the delayed penetration of the dark eggs is their hardness. The successful but delayed penetration may possibly be explained in that for each attempted feeding (or any feeding) a clear liquid substance exuded from the mouthparts is placed on the egg. The repeated subjection of eggs to this saliva may soften the egg shells sufficiently for later penetrations. The cultures of chiggers feeding on Neoperla and Isoperla eggs contained from 50 to 75 adults and nymphs. The nymphs and adults moved from egg to egg wetting each egg repeatedly. In one instance only, the eggs of an unidentified stone-fly were thought to

toxic, apparently killing over half of a culture of 50 nymphs and adults.

7. Mallophaga:-- The eggs of Trichodectes were obtained from a coyote, Canis latrans Say. The eggs of an undetermined Mallophaga were picked from the feathers of several species of birds. There was no evidence as to the age of the eggs or the development of the embryo; none of these eggs were eaten. Since the eggs are attached to feathers and hairs, they may not be available in nature. No dissections of the adults were made.

8. Anoplura:-- Eggs obtained from the hairs of a rat, Rattus norvegicus (Berkenhout), were not eaten. As in the case of Mallophaga eggs, they may not be available in nature. No dissections of the adults were made.

9. Thysanoptera:-- Many specimens were dissected before one was found with large eggs, and these contained well advanced embryos with visible segmentation and red eye spots. The five or six embryos were covered with a thin, hyaline membrane. While still within the abdomen, they were offered to T. splendens and were eaten within five minutes; the embryos only were eaten. Subsequently, 12 of 20 freshly dead adult thrips (not sexed) placed in a culture dish without being dissected were fed upon. The feeding punctures were made in the second to the fourth intersegmental membranes of the abdomen.

10. Hemiptera:-- The eggs of many Lygaeidae such as Geocaris, Nysius, and Ischnodemus, probably are available in nature. The mature eggs were eaten consistently, and remained acceptable in the laboratory for many days after removal from the insects. The immature oocytes of an unidentified pentatomid appeared to be repellant to T. splendens and Sinella. This was the only exception noted in the Hemiptera. The laid eggs of large pentatomids appeared acceptable but many were too hard to be punctured.

11. Homoptera:-- Some of the eggs of Homoptera may be found and eaten in nature; however, since most Homoptera lay their eggs in plant tissues, their eggs are probably rarely available to chiggers.

12. Dermaptera:-- The eggs of some earwigs may serve as food in nature. Laboratory evidence has shown that freshly laid eggs were preferred, eggs eight days old or older were ignored. For the most consistent results mature dissected eggs should be used in cultures of nymphs and adults. Most nymphs were not successful in puncturing large freshly laid eggs. When feeding on soft dissected ovaries, the entire "beak", palps, and the tarsi of the anterior pair of legs were buried deeply in the soft wet food.

13. Coleoptera:-- Many eggs of the Coleoptera are probably available in nature. The laboratory evidence is confusing. There seemed to be a gradient of acceptance of the ovaries and particularly in the Chrysomelidae, some of these were thought to have toxic or lethal effects. Toxicity was also suspected in some of the Meloidae and Coccinellidae. Many large eggs were too hard to puncture. Some were apparently repellant, as in the Cantharidae, Dermestidae, Coccinellidae, and Chrysomelidae (See table I).

14. Trichoptera:-- Although the larvae of caddisflies are aquatic, many adults are found considerable distances from water and their bodies with their eggs may become available in nature. The mature eggs of caddisflies compare with the eggs of small moths in attractiveness.

15. Lepidoptera:-- Moth eggs probably offer more possibilities in nature than do the eggs of butterflies; in either case, many of their eggs are laid on plants and are hence unlikely to be available to chiggers, but some phalaenids and others lay their eggs in or on the soil.

16. Diptera:-- The mature eggs of most Diptera were eaten in the laboratory, none seemed

toxic, some were not attractive and the laid eggs of a stratiomyiid, Ptecticus, were repellant to chiggers as well as to Sinella. The hardest eggs were the laid eggs of a large Tipulinae but most of these were punctured, often days after they were laid. The laid eggs of Musca domestica and a few other muscids were not eaten, perhaps because the larvae were well formed in the eggs. The same condition seemed to exist with the Sarcophagidae and Drosophilidae. The larvae hatched from these eggs within 24 hours in most cases. Many eggs of Diptera may serve as food in nature.

17. Siphonaptera:-- The laid eggs of fleas were not eaten. The dissected eggs of Orchopeus and Ctenocephalides compared favorably with those of Diptera. Under certain conditions, the eggs of fleas may be available to chiggers in nature.

18. Hymenoptera:-- Mature eggs of Hymenoptera were difficult to find because the majority of their eggs are laid singly and their availability in nature must be negligible.

19. Phalangida:-- The mature but soft eggs were readily eaten. Additional body content was offered but no interest was shown on material other than ovarian.

20. Araneida:-- One egg-sac of a lycosid spider was recovered from a female. The eggs were apparently freshly laid and many of these were punctured and eaten although a delay of a few days seemed to be necessary before some of the eggs could be punctured. No ovarian dissections were made upon the adult lycosid spiders. Several egg-sacs were collected from under loose bark on trees and stumps and apparently were the eggs of agelenid spiders. Two of these sacs contained relatively freshly laid eggs which were eaten. Eggs with noticeable embryonic development seemed unattractive and were not eaten. No ovarian dissections were made. A number of egg-sacs of undetermined spiders resembling those of Gnaphosidae (Drassidae) were found under rocks and stones, and beneath loose bark on trees and stumps. The eggs

in the majority of these were in advanced stages of differentiation and showing pigmentation. Only the clear eggs were eaten.

21. Acarina:-- The only ixodid (tick) eggs offered to chiggers as food were the eggs of Amblyomma americanum (Linnaeus). Although there was no evidence of advanced embryonic differentiation, these eggs were not eaten. These eggs were neither attractive nor repellant. Ovarian dissections were not made. The eggs of two species of acarid mites were often available in chigger cultures. Only rare feeding attempts were made on these and none were positively determined as completely eaten but a few punctures were made by both nymphs and adults. Hypopial stages were not attacked by chiggers. However, one adult chigger was seen attacking a large acarid. Eggs of several small mites other than the acarids were often found in chigger cultures but none appeared to be eaten.

Under starvation conditions, the acarids attacked and successfully killed nymphal and adult chiggers. Those chiggers with slight imperfections or wounds in the integument were the first to be attacked and when supported by numerous acarids, adult chiggers were eaten within two days. The parts fed upon by the acarids were moist and the chigger was helpless against the attacks. This stage attached to the nymphs and adults of chiggers particularly in cultures maintained in large terraria. Frequently, more than a hundred hypopi were found attached to adult chiggers, on the legs, palpi, chelicerae, and other areas of the gnathosoma. The hypopi often occured in clusters, attached to each other, and when on the anterior parts of the gnathosoma they interferred with feeding. Attachment lasted from one to three or even four weeks.

Toxicity of Sinella Eggs

As noted in the preceding pages, eggs of a few kinds of arthropods seem toxic to chiggers. Those of Sinella curviseta, however, are normally nontoxic and very useful in rearing chiggers. On several occasions, however, they have proven extremely toxic to at least five species of chiggers.

This toxicity was attributed to fungi of the genus Penicillium, the species of which were not positively identified. Cultures and generic identification were made by Dr. N. M. McClung of the University of Kansas. One species was definitely responsible for a severe toxicity, resulting in death, of the nymphs and adults which fed upon the infected eggs of this collembolan.

This Penicillium infected the Sinella eggs laid in cultures (both chigger cultures containing Sinella and pure cultures of the collembolans). The severity of toxicity appears to depend upon the growth stage and species of the mold within the eggs. The infected eggs are easily distinguished within a short time by the production of a pink pigment within the egg, although eggs may be toxic to some degree before their pigmentation becomes apparent. When egg pigmentation is not pronounced, the chigger mites may feed on several Sinella eggs and develop symptoms of discoordination, lethargy, and quiescence. Most generally, eggs with noticeable pink pigmentation produce the most strikingly toxic reactions. The penetration of the egg may result in immediate effects, even to the cessation of feeding, with the chelicerae buried in the egg and a completely moribund condition. Nymphs and adults are equally affected and inactivity and perhaps death may occur within a very few minutes.

Summary

The laboratory feeding trials suggest that the eggs of many insects as well as other arthropods may serve as food for postlarval chiggers in nature. Some eggs appear to be repellant, toxic, or unattractive as food. The mature but unlaid eggs of some species were eaten, although the laid eggs of the same species were apparently repellant or not accepted. Some chiggers apparently do not feed on ovarian material but prefer to feed only on the fluids that may be obtained from the bodies of small quiescent arthropods.

Some insect eggs are apparently toxic; those suspected are some of the Plecoptera, and Coleoptera of the families Meloidae, Coccinellidae, and

Chrysomelidae. The eggs of these may or may not be available to chiggers. The fact that the eggs of Sinella curviseta are normally nontoxic but when infected with a Penicillium they become extremely lethal supports the probability of the toxic effects being caused by an infectious agent. However, this should not exclude the possibility that some eggs are naturally poisonous to chiggers.

Eggs believed to be the most important sources of food for nymphal and adult Trombicula are those of many Diptera, certain Hemiptera (e. g. Lygaeidae), a few Lepidoptera (some Phalaenidae), and entomobryid Collembola. Eggs of many Lepidoptera, Hemiptera, Homoptera, Trichoptera, and Araneida seem equally acceptable but because of the egg laying habits of most members of these groups, they are not readily available to the chiggers. Eggs of Orthoptera, Coleoptera, Mallophaga, Anoplura, Siphonaptera, and Acarina are not particularly attractive to chiggers

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Table I

Feeding Trials Based on Nymphs and Adults of
Chiggers (principally Trombicula (Eutrombicula) alfreddugesi and splendens)

ORDER and Family	Genus	Laid eggs	Dissected mature eggs	Half grown oocytes	Small oocytes	Probable Importance in Nature
COLLEMBOLA						
Entomobryidae	Sinella	(50) XXX				?
	Undetermined	(50) XXX				G
Poduridae	"	(50) 0				P
Sminthuridae	"	(10) 0				P
ORTHOPTERA	Melanoplus		(2) -0 X	(1) 0 X	(2) 0 XX	P
Locustidae	Dissosteira		(2) -0 X	(2)-0 XX	(2) XX	P
	Mermiria			(4) XX	(5) XXX	F
	Schistocerca		(1) -0	(1)-0 X	(1) XX	P
	Syrbula				(3) XXX	F
Gryllidae	Gryllus	(12)AD X	(2)AD XX	(2) XXX		F
	Nemobius				(6) XXX	F
	Oecanthus				(5) XXX	P
Blattidae	Periplaneta	(1) 0	(2)			P
Tettigoniidae	Neoconocephalus		(2) 0	(2) XX	(2) XXX	P
	Scudderia		(5) 0	(5) XX	(5) XXX	P
Tettigidae	Undetermined				(1) C ?X	
NEUROPTERA						
Sialidae	Sialis		(10) XXX	(2) XX		P
Hemerobiidae	?Hemerobius		(3) XXX	(1) XX		P

Chrysopidae	Chrysopa		(14) XX	(3) XX		P
Ascalaphidae	Undetermined		(1) O			P
EPHEMERIDA						
Ephemeridae	Hexegenia		(25)AD XX			P
ODONATA						
Libellulidae	Libellula		(1) XXX	(1) XXX	(1) XXX	P
PLECOPTERA	Neoperla	(20)AD X	(20)D XX	(20) XXX	(20) XXX	P
Perlidae	Isoperla	(20)AD X	(20)D XX	(20) XXX	(20) XXX	P
MALLOPHAGA						
Trichodectidae	Trichodectes	(25) O				P
	Undetermined	(10) O				P
ANOPLURA						
	Polypax	(10) O				P
THYSANOPTERA						
	Undetermined		(1) XXX			P
HEMIPTERA						
Anthocoridae	Undetermined		(2) XXX	(2) XXX		P
Nabidae	Nabis		(1) XX			P
Neididae	Undetermined				(15) XX	P
Miridae	Lygus		(50) XXX	(50) XXX	(50) XXX	P
	Lopidea		(5) XXX	(5) XXX	(5) XXX	P
	Halticus		(10) XXX	(10) XXX	(4) XXX	P
	Deraeocoris		(2) XXX	(3) XXX	(3) XXX	P
Lygaeidae	Geocoris		(50) XXX	(10) XXX	(10) XXX	G
	Nysius		(50) XXX	(50) XXX	(25) XXX	G

	Lygaeus		(10) XXX	(10) XXX	(10) XXX	G
	Ischnodemus		(50) XXX	(50) XXX	(50) XXX	G
	Blissus		(5) XXX	(2) XXX	(3) XXX	G
Pentatomidae	Brochymena		(1) XXX	(2) XXX	(2) XXX	F-P
	Acrosternum		(1) XXX	(1) XXX	(1) XXX	F-P
	Thyanta		(2) XXX	(2) XXX	(2) XXX	F-P
	Euschistus		(3) XXX	(3) XXX	(3) XXX	F-P
	Undetermined	(20)A X			(1) -	F
Scutelleridae	Undetermined			(2) XXX	(2) XXX	F-P
HOMOPTERA						
Cercopidae	Undetermined		(2) XX	(2)C ?X	(2)C ?	P
Membracidae	Ceresa			(4) XXX	(4) XXX	P
Cicadellidae	Aceratagallia		(5) XXX	(5) XXX	(5) XXX	P
	Exitianus		(10) XXX	(10) XXX	(5) XXX	P
	Draeculacephala		(50) XXX	(50) XXX	(25) XXX	P
	Graphocephala		(50) XXX	(50) XXX	(50) XXX	P
	Phelepsius		(25) XXX	(25) XXX	(10) XXX	P
	Gypona		(10) XXX	(10) XXX	(5) XXX	P
	Cicadula		(15) XXX	(15) XXX	(5) XXX	P
	Polyamia		(3) XXX	(3) XXX	(2) XXX	P
	Empoasca		(15) XXX	(10) XXX	(5) XXX	P
	Erythroneura		(15) XXX	(10) XXX	(5) XXX	P
Fulgoridae	Scolops			(4) XXX	(4) XXX	P
	Ormenis		(1) XXX	(1) XXX	(2) XXX	P
	Phylloscelis		(2) XXX	(2) XXX	(3) XXX	P
	Acanalonia		(5) XXX	(1) XXX	(1) XXX	P
	Poblecius			(4) XXX		P

(Delphacinae)	Undetermined		(50) XXX	(50) XXX	(25) XXX	P
Aphidae	Undetermined	(10) ?0				P
DERMAPTERA						
Labiduridae	Labidura	(50)AOXX	(25) XXX	(25) XXX	(25) XXX	F
COLEOPTERA						
Cicindellidae	Cicindella				(5) XXX	G
Carabidae	Harpalus		(5) O	(5) O X	(3) XX	P
	Pterostichus		(3) O	(4) O XX	(2) XX	P
Cantharidae	Chauliognathus		(10)-O X	(6)-O X	(10)-O?X	P
Meloidae	Epicauta			(3) O X	(5) O XX	P
Elateridae	Melanotus			(2) X	(5) X	P
	Aeolus			(3) X	(5) X	P
Dermestidae	Dermestes		(5) -	(5)-O X	(10)-O X	P
Coccinelidae	Adalia	(20)-O	(2) -O	(3) O X	(6) O X	P
	Ceratomegilla		(4)-O ?X	(3) O X	(3) O XX	P
Tenebrionidae	Tenebrio		(5) O ?X	(5) O X	(2) O XX	F
Scarabiidae	Phyllophaga			(2) O X	(5) O X	P
Chrysomellidae	Epitrix		(10)-O XX	(6) O XX	(2) XX	F
	Cerotoma		(4)-O X	(2) O X	(2) XX	P
Curculionidae	Undetermined				(3) X	P
TRICHOPTERA						
	Undetermined		(25) XXX	(25) XXX		P
LEPIDOPTERA						
Eriocranidae	Undetermined		(2) XXX	XXX	XXX	P
Tineidae	"		(5) XXX	XXX	XXX	G
Gelechiidae	"		(5) XXX	XXX	XXX	P
Coleophoridae	"		(1) XXX	XXX	XXX	P
Tortricidae	"		(15) XXX	XXX	XXX	P

Pyralidae	Undetermined		(15) XXX	XXX	XXX		P
Pterophoridae	"		(15) XXX	XXX	XXX		P
Geometridae	"		(25) XXX	XXX	XXX		P
Notodontidae	"		(3) XXX	XXX	XXX		P
Phalaenidae	"		(10) XXX	XXX	XXX		G
Arctiidae	Undetermined		(3) XXX	XXX	XXX		P
Hesperiidae	"		(8) XXX	XXX	XXX		P
Pieridae	Pieris	(5) XXX	(6) XXX	XXX	XXX		P
	Colias		(2) XXX				
Nymphalidae	Brenthis		(5) XXX	XXX	XXX		P
	Phyciodes		(5) XXX	XXX	XXX		P
Satyridae	Undetermined		(10) XXX	XXX	XXX		P
Lycaenidae	Lycaena		(10) XXX	XXX	XXX		P
	Thecla		(1) XXX	XXX	XXX		P
DIPTERA							
Tipulidae	Undetermined	(50) XXX	(50) XXX	(50) XXX			G
Chironomidae	Undetermined	(25) XXX	(20) XXX	(20) XXX			F
Culicidae	Culex	(50) XXX	(30) XXX	(20) XXX	(10)	XXX	P
	Aedes	(50) XXX	(20) XXX	(20) XXX	(5)	XXX	G
Cecidomyidae	Undetermined		(20) XX	(15) XXX			G-P
Sciaridae	Sciara		(15) XXX	(5) XX	(5)	XX	G
Mycetophilidae	Undetermined		(50) XXX	(50) XXX	(10)	XXX	G
Stratiomyidae	Ptecticus	(30)-	(5) XXX	(7) XXX			P
Tabanidae	Chrysops				(5)	XX	P
	Tabanus				(3)	XX	P
Rhagionidae	Undetermined		(6) XXX	(6) XXX			F
Asilidae	Undetermined				(2)	XX	F

Therevidae	Undetermined		(10)	XXX	(6)	XXX	(1) ?XX	G
Bombylidae	"				(2)	?XX		P
Empidae	"		(30)	?XX	(30)	XX		G-P
Dolichopodidae	"		(50)	XXX	(50)	XXX	(20) XXX	G
Lonchopteridae	"		(10)	XXX	(10)	XXX	(2) XX	G
Phoridae	"		(10)	XXX	(5)	XX		G-P
Platypezidae	"						(2) XX	?
Syrphidae	Mesogramma		(20)	XXX	(15)	XXX	(15) XXX	G-P
Otitidae	Eumetopiella		(20)	XXX	(30)	XXX		P
Trupaneidae	Undetermined		(20)D	XXX	(20)	XXX	(10) XXX	P
Sepsidae	"		(20)	X	(10)	X		P
Ephydridae	"		(20)	X	(10)	X		F-P
Lauxaniidae	"		(5)	XX	(5)	XX		G
Drosophilidae	Drosophila	(50) O X	(25)	XXX	(25)	XXX		F-P
Agromyzidae	Undetermined		(50)	XXX	(50)	XXX	(50) XXX	P
Chloropidae	"		(50)	XXX	(50)	XXX	(50) XXX	G
Borboridae	"						(10) X	?
Tetanoceridae	Haplodictyis						(20) XX	?
Muscidae	Musca	(50) O X	(50)	XXX	(50)	XXX	(20) XXX	F
Anthomyidae	Undetermined		(50)	XXX	(50)	XXX	(10) XXX	G
Sarcophagidae	Undetermined	(20) O	(25)	XXX	(25)	XXX	(5) XXX	P
Tachinidae	Undetermined		(50)	XXX	(50)	XXX	(10) XXX	P
SIPHONAPTERA								
	Orchopeus	(10) O	(2)	XXX				P
	Ctenocephalides	(10) O	(3)	XXX				P
	Nosopsyllus	(10) O						P
	Undetermined	(25) O						P

HYMENOPTERA						
Andrenidae	Undetermined				(3) X	P
Pompilidae	"			(3) O X	(5) X	P
Vespidae	"			(2) O X	(3) X	P
Ichneumonidae	Ophion		(3) O ?X	(5) XX	(1) X	P
	Paniscus		(2) XX	(3) X	(3) O X	P
Braconidae	Undetermined		(2) XXX	(5) XX	(8) X	P
PHALANGIDA	Undetermined		(2) XXX			G
ARANEIDA						
Lycosidae	Undetermined	(50) D XX				P
Aglenidae	Undetermined	(50) XXX				P
Undetermined		(50) XXX				P
ACARINA						
Ixodidae	Amblyomma	(50) O				P
Acaridae	Undetermined	(50) O X				P
Undetermined		(50) O				P